

TOPIC 3

COMPUTER Hardware Basics

Computer is more than just a processor or screen; it is an integrated system whose components collaborate to execute complex analytical workflows.

• Central Processing Unit (CPU).

The CPU is the "brain" of the computer. It actually executes instructions organized into programs (software) that determine the computer's actions.

Role in Biostatistics.

- Executes statistical algorithms, such as regression, survival analysis, and Bayesian inference.
- Enables simulations for epidemiological modeling and clinical trial scenario projections.

Role in Financial Engineering.

- Runs high-speed option pricing models, Monte Carlo simulations, and algorithmic trading strategies.
- Determines execution latency in high-frequency trading (HFT) systems.

Technical Insight.

- Multi-core CPUs enable parallel computation of independent simulations (e.g., bootstrap resampling or Monte Carlo iterations).
- Vectorized instructions (SIMD) accelerate linear algebra operations in large cohort

or portfolio datasets.

Memory (RAM)

Random Access Memory (RAM) is fast, volatile, and relatively expensive. It temporarily stores:

- Active programs.
- Data currently processed.
- Intermediate results.

Analytical Relevance

Biostatistics: Holding large patient datasets or multi-dimensional Matrices during Computation-intensive Survival or Longitudinal analyses.

Financial Engineering: Storing large Covariance Matrices, time series data and intermediate stages in Stochastic Simulations.

Key Consideration

Insufficient RAM causes disk swapping, which drastically slows Computations in both health and financial simulations.

Mass Storage Devices

- Mass Storage refers to slower, long-term memory that retains data between Computational jobs.

Examples:

- Hard Disk Drives (HDDs).
- Solid-State Drives (SSD) (SSDs).
- Tape Drives (Archival).

Input Devices

Input devices deliver data and instructions into the system.

Analytical Examples

- **Biostatistics**: Clinical trial data, Lab Measurements, Survey inputs.
- **Financial Engineering**: Market data feeds, Simulation Parameters, Scenario.

Modern Considerations

Input increasingly arrives via digital pipelines

- APIs.
- Networked sensors.
- Electronic Data Capture (EDC) systems.

Output Devices

Output devices - Monitors, Printers, dashboards - Visualize Computational results.

Domain Examples

Biostatistics: Kaplan-Meier Plots, Epidemic Curves, gene expression heatmaps.

Financial Engineering: VaR reports, risk dashboards, real-time analytics.

Analytical Insight

Clear output is essential for interpreting Multi-dimensional datasets or Model diagnostics.

EX 1

This Code Measures how Computer affects analytical Performance.

it benchmarks CPU speed using parallel Monte Carlo simulation, RAM efficiency using a large matrix operation, and storage performance through disk read/write tests. It prints these results and visualizes all three timings with annotated, color-coded subplots in one row.